

REMARKS

Claims 4 and 76, 77 and 81-85 are pending in the present patent application. In an Office Action mailed January 3, 2002, the Examiner rejected claim 4 under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent No. 5,913, 145 to Lu *et al.* ("Lu"), and rejected claims 4-9 and 76-88 under 35 U.S.C. § 103(a) as being unpatentable over the present specification in view of United States Patent No. 6,201,276 B1 to Agarwal *et al.* ("Agarwal").

Under 35 U.S.C. § 103(c), "[s]ubject matter developed by another person, which qualifies as prior art only under one or more of subsections (e), (f), and (g) of section 102 of this title, shall not preclude patentability under this section where the subject matter and the claimed invention were, at the time the invention was made, owned by the same person or subject to an obligation of assignment to the same person." Vishnu K. Agarwal is the sole inventor in the present application and one of the inventors in the Agarwal patent, and Agarwal patent qualifies as prior art only under subsections (e), (f), and (g). The undersigned states as follows regarding the common ownership of the Agarwal patent and the invention covered by the present patent application:

Statement Regarding Common Ownership

The Agarwal patent and the invention covered by the present patent application were, at the time the invention covered by the present application was made, subject to an obligation of assignment to Micron Technology, Inc., which is the assignee of the present application and the Agarwal patent.

Accordingly, the Agarwal patent may not be applied as prior art under Section 103 against the claims of the present application, and claims 76, 77 and 81-85 are therefore allowable. *See* MPEP § 706.02(1)(1)-(2).

In order to help the Examiner appreciate certain distinctions between the pending claims and the subject matter of the applied references, the disclosed embodiment of the invention will now be discussed in comparison to the applied references. Specific distinctions between the pending claims and the applied references will be discussed after the discussion of the disclosed embodiment and the applied references. This discussion of the differences between

the disclosed embodiment and applied references do not define the scope or interpretation of any of the claims.

Applicant's invention exposes a conductive layer to an oxygen-inhibiting plasma or other gas, including nitrogen free gases, prior to the formation of the another layer or layers on the conductive layer to substantially reduce the association of oxygen with the conductive layer during formation of the other layer or layers. By reducing the amount of oxygen associated with the conductive layer, the electrical characteristics of a semiconductor device including the conductive layer are improved, as will be discussed in more detail below with reference to the disclosed embodiments of the invention. One embodiment of the present invention is discussed with reference to Figures 7-10 in which an interposing layer 52 such as a tungsten nitride layer 52 is formed between a conductive plug 46 formed in a via 44 and a conductive line material 48 formed in a trench or container 50. The tungsten nitride layer 52 enhances the electrical contact between the line material and the plug, promotes adhesion of the line material within the container 50, and prevents or slows the diffusion of materials across the tungsten nitride layer boundary, or serves some other purpose. The tungsten nitride layer 52 may associate with oxygen after it is formed and subsequent thermal processes may result in the formation of an oxide layer 54 formed between the tungsten nitride layer 52 and the line material 48 as shown in Figure 8. Because the oxide layer 54 is an insulator, this layer will adversely affect the electrical connection between the line material 48 and the plug 46.

By exposing the tungsten nitride layer 52 to an oxygen-inhibiting agent or a reducing atmosphere prior to formation of the line material 48, the thickness of the oxide layer 54 is reduced to a thickness of less than 10 angstroms or entirely eliminated as illustrated respectively in Figures 9 and 10. As described in the specification, the tungsten nitride layer 52 or other conductive layer may be treated with gases such as diborane B_2H_6 , PH_3 , CH_3SiH_3 , $(CH_3)_3Si-Si(CH_3)_3$, HMDS, CF_4 , CHF_3 , HCL , BCl_3 , and silane SiH_4 , and any combinations of these gases, as described on page 7, lines 25-30, page 8, lines 1-16, and page 9, lines 1-12.

Lu discloses forming a thermally stable diffusion barrier layer that is more thermally stable than a titanium nitride layer applied directly on the substrate. Figures 1A-E illustrate the formation of a thermally stable diffusion barrier layer by forming a layer of titanium 11 on a substrate 10 and thereafter forming a layer of tungsten nitride 12 on the titanium layer. The substrate 10 and layers 11 and 12 are thereafter annealed, causing the titanium layer 11 to

react with the underlying substrate 10 to form an interfacial layer 11'. During this process, the tungsten nitride layer 12 is converted to titanium nitride layer 12', and a tungsten layer 13' is formed on the layer 12'. The titanium nitride layer 12' provides a more stable diffusion barrier than conventional deposited titanium nitride layers.

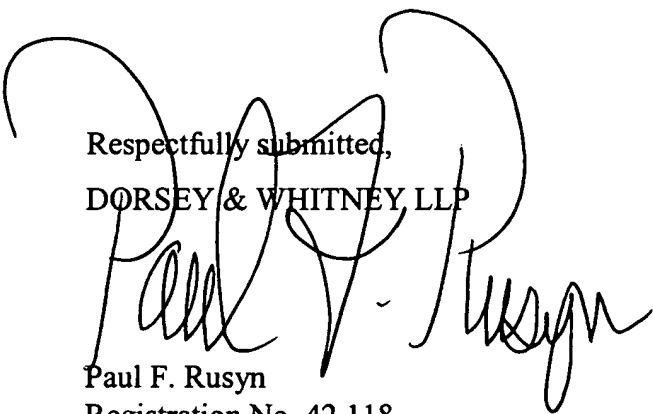
Lu is directed to forming an improved barrier layer and is not directed to preventing the association of oxygen with a layer to prevent subsequent oxide layers from forming. Moreover, Lu neither discloses nor suggests exposing a conductive layer to a selection consisting of diborane, phosphine, methylsilane, hexamethyldisilane, hexamethyldisilazane, HCL, boron trichloride, and combinations thereof to passivate the conductive layer and thereby reducing the ability of the layer to associate with oxygen. The same is true of the Agarwal patent.

Claim 4 recites a method of passivating a conductive material. The method includes providing the conductive material having an ability to associate with oxygen and directly exposing the conductive material to a selection consisting of diborane, phosphine, methylsilane, hexamethyldisilane, hexamethyldisilazane, HCL, boron trichloride, and combinations thereof. This exposure reduces the ability of the conductive material to associate with oxygen prior to forming another conductive material on the conductive material. Lu neither discloses or suggests exposing a conductive layer to a selection consisting of diborane, phosphine, methylsilane, hexamethyldisilane, hexamethyldisilazane, HCL, boron trichloride, and combinations thereof. The combination of elements recited in claim 4 is therefore allowable over Lu and Agarwal, as well as the other prior art of record, whether taken individually or in combinations.

All pending claims are in condition for allowance, and favorable consideration and a Notice of Allowance are respectfully requested. The Examiner is requested to contact the undersigned at the number listed below for a telephone interview if, upon consideration of this amendment, the Examiner determines any pending claims are not in condition for allowance.

Attached hereto is a marked-up version of the changes made to the claims by the current amendment. The attached page is captioned **"Version with Markings to Show Changes Made"**.

Respectfully submitted,
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PFR:asw

Enclosures:

Postcard
Fee Transmittal Sheet (+ copy)
Supplemental Information Disclosure Statement
Form PTO-1449 with Cited References (3)

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Claims:

Claims 5-9, 78-80, and 86-88 have been cancelled.

Claims 4, 76, 77, 81, and 85 have been amended as follows:

4. (Twice Amended) A method of passivating a conductive material, comprising:

providing said conductive material, wherein said conductive material has an ability to associate with oxygen; and

directly exposing said conductive material to a [plasma] selection consisting of diborane, phosphine, methylsilane, hexamethyldisilane, hexamethyldisilazane, HCL, boron trichloride, and combinations thereof to reduce the ability of the conductive material to associate with oxygen prior to forming another conductive material on the conductive material.

76. (Amended) A method of passivating a conductive layer, comprising:

providing a tungsten nitride layer;

providing a polysilicon layer on the tungsten nitride layer; and

[directly] exposing the tungsten nitride layer to a [plasma] selection consisting of diborane, phosphine, methylsilane, hexamethyldisilane, hexamethyldisilazane, HCL, boron trichloride, and combinations thereof to passivate the tungsten nitride layer prior to formation of the polysilicon layer on the tungsten nitride layer.

77. (Amended) The method in claim 76, wherein exposing the tungsten nitride layer [to a plasma] causes a reduction in an ability of the tungsten nitride layer to associate with oxygen.

81. (Amended) A method of passivating a conductive layer, comprising:
providing a first conductive plug;
providing a first conductive layer on the plug;
[directly] exposing the first conductive layer to a [plasma] selection consisting of diborane, phosphine, methylsilane, hexamethyldisilane, hexamethyldisilazane, HCL, boron trichloride, and combinations thereof to passivate the first conductive layer; and
after exposing the first conductive layer [to a plasma to passivate the first conductive layer], forming a second conductive layer on the first conductive layer.

85. (Amended) The method of claim 81 wherein exposing the first conductive layer [to a plasma to passivate the first conductive layer] reduces an ability of the first conductive layer to associate with oxygen.